THE SODIUM POTASSIUM RATIO IN INSECTS.

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A THESIS SUBMITTED TO THE DEPARTMENT OF CHEMISTRY AND THE FACULTY OF THE GRADUATE SCHOOL IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MASTERS DEGREE.

APPROVED .....H B Dains.....

DEPARTMENT OF CHEMISTRY.

DATE.....

THE SODIUM POTASSIUM RATIO IN INSECTS.

Potassium is never found free, but is widely distributed in nature. (1). There are only two large deposits of potassium salts known, one near Stassfurt, Germany, and a smaller one at Kalusz, Austria. Many of the deposits in our own country are said to contain potassium, but Searles Basin in California is the only place in the Great Basin where the concentrates of potassium salts in the residual brine is great enough to be a possible source of potassium.(2).

Practically no references could be found as to the amount of potassium and sodium in insects, but I have gathered together all the material I could find which would throw any light on the subject. I have given references to show that potassium and sodium are found in practically all plants and animals, and that the proportion, while small, varies greatly. I have emphasized that potassium is an important element in the cell and as such we should expect to find potassium in insects. I have given the relative proportions of potassium and sodium in animal and plant products and have listed the ratio of sodium to potassium in substances when given.

Growing plants seem to have an imperative need for compounds of the alkali metals, i.e., potassium and sodium. Those plants which grow on the land take up potassium compounds from the soil to such an extent that their ashes formerly constituted the chief source of these compounds. (1).

Sea plants are rich in sodium and the supply of sodium is practically without limit.

Herbivorous animals get with their food much larger quantities of potassium and smaller quantities of sodium than they need, The elimination of the unnecessary potassium seems to be unavoidably accompanied by the excretion of the useful sodium compound, and this accounts for the great appetite for sodium chloride by herbivorous animals. Carniverorous animals get their sodium and potassium in the proper proportion in their food and hence do not care especially for salt.

Potassium is essential to most plants although it occurs in relatively small proportions. (3) Most plants contain a small amount of potassium as shown by the following:

The chlorophyl of beets (sugar) and barley were found to contain .43 and .57 % of potassium oxide. (4)

Hedge clippings and trimmings gave an ash containing 10.9 % potassium oxide. (5)

In phanerograms, potassium is most abundant in the parenchyma, especially in the growing plants and reserve organs. (6) In the secondary tissue it predominates in the living elements of the wood and bark, especially in the cambium and medullary rays; the latter seem to act as potassium reserves for the growth of new shoots. Potassium seems to play little or no part in the assimilation of carbon, but probably shares in building up protoplasm in growing points. In the leaf it probably aids in the synthesis

and degradation of protein.

Potassium in sugar cane juice varies from .173 to.208 and depends on the soil, on the fertilization, climate, and the variety. (7) The white smoke coming from a sugar mill when burning molasses is composed very largely of potassium salts. (8) The incrustations from the insides of a tubular boiler showed a mixture of quite pure potassium sulphate and potassium chloride.

Potatoes raised on a soil containing sodium gave an ash which analyzed potash 38.18 % and sodium only a trace. (9)

The dry seed of hyoscyamus niger gave an ash containing 17.54 % potassium oxide and 5.4 % sodium oxide. The ash totaled 2.43 % of the dry sample. (10) Analysis of the ash of eupharbia amygdaloides gave the following results: Total ash 5.94 % of the air dried sample. A sample grown on siliceous soil gave 33.4 % potassium oxide and . 29% sodium oxide. Herniaria glabra when analyzed gave a total ash of 7.13 % when grown on siliceous soil. The ash analyzed 24.38% potassium oxide and 4.11 % sodium oxide. When grown on dolmite soil the total ash was 6.62 %. This gave 8.68 % potassium oxide and 3.86 % sodium oxide.

An analusis of two kinds of eucalyptus gave the following results: (12). E. rostrata gave 2.25 % ash which analyzed 9.5 % potassium oxide and 3.4 % sodium oxide. E. globulus gave 2.1 % ash which analyzed 25 % potassium oxide and sodium oxide. Haricots were used in an experiment for the determination of potassium compounds. The ash varied from 10 to

15 % of the entire plant; the ash analyzed - (13)

insoluble		soluble.	
SiO_2	7.2 %	K_2CO_3	33. %
CaO	29.6 %	KCl	.6 %
$Mg_2P_2O_7$	11.2 %	K_2SO_4	7,4 %
MgO	2. %		
CO_2	9. %		

There was no soda in the ash.

Potassium is present in all parts of Thallophytes, in Phanerogams and is found mostly in young embrynol tissue rich in plasma and in the parenchyma of the leaves, seeds, roots, and stems. (14)

The knowledge of animal chemistry is very limited, (15) and but few references could be found which could be used for comparisons.

The total percent of the elements found in the human body are as follows: (16)

Mg .05; Fe .004; O .66; C 17.5; H 10.2; N 2.4;

P .9 ; K .4 ; Na.3 ; Cl .3; Ca 1.6; S .2;

Also a trace of I, F, and Si.

The body of a man weighing 154 lbs., consists of the following approximate parts: Of sodium as sulphate phosphate and carbonate, 2.2 oz; of potassium as sulphate phosphate and carbonate, 1.7 oz. Potassium is necessary for the development of the cells especially in the blood and muscles. (17) Sodium is required to keep certain proteins in solution and to make secretions of a proper composition. When young animals are deprived of potash

salts they do not develop muscle properly. Possibly the chief use of potassium in the human organism is that of an acid carrier; at any rate the organic acids combined with it undergo oxidation in the system, become transformed into alkali carbonates which render the blood and the urin alkaline. Potassium salts are chiefly found in vegetable foods, and animal foods furnish more sodium salts.

Potassium and Sodium salts found in 1000 parts of the dried substance are as follows:

	K_2O	Na_2O
Rice	1.00	.03
Bullocks blood	2.00	19.00
Oats, wheat, rye, barley	5.-6.	.1-.4
Dogs milk	5.-6.	2.-3.
Human milk	5.-6.	1.-2.
Apples	11.	1.
Peas	12.	2.
Milk of herbivora	9.-17.	1.-10.
Beef	19.	3.
Beans	21.	.1
Strawberries	22.	.2
Potatoes	20.-28	.3-.6

The ratio of Sodium to Potassium in certain substances was found to be as follows:

Blood	Na:K:: 1 : .07
Egg yolk	Na:K:: .7
Egg albumin	Na:K:: .1
Milk of carnivora	Na:K:: .8: 1.6

Milk of herbivora	Na:K::	.8:	.6
Milk of women	Na:K::	1. :	4.
Beef	Na:K::		4.
Wheat	Na:K::	12. :	23.
Barley	Na:K::	14. :	21.
Oats	Na:K::	15. :	21.
Rice	Na:K::		24.
Rye	Na:K::	9. :	57.
Potatoes	Na:K::	31. :	42.
Peas	Na:K::	44. :	50.
Strawberries	Na:K::		71.
Apples	Na:K::		100.
Beans	Na:K::		110.

The chemical composition of new born children is as follows: (18)

	% H_2O	Fat.	Ash.	Protein and gelatin.	Ex.
Two male.	71	13.	2.7	12.	1.2
" female.	72	12.	2.6	11.	1.6

A comparison is made of the chemical composition of the ash of a new born babe and of human milk, giving the results as reported by de Lange and Soldner.

Ash of Infant.

	DE LANGE.	SOLDERN.
K_2O	6.5	7.8
Na_2O	8.8	9.1
CaO	38.9	36.1
MgO	1.4	.9

	DE LANGE	SOLDERN.
Fe_2O_3	1.7	.8
P_2O_5	37.6	38.9
Cl_2	6.3	7.7
Ash of Human Milk.		
K_2O	19.9	31.4
Na_2O	29.6	11.9
CaO	12.9	16.4
MgO	2.9	2.6
Fe_2O_3	.25	.16
P_2O_5	17.9	13.5
Cl_2	21.3	20.

Fish meal and fish manure give from 2 to 4 % Potassium. (19)

Bat guana contains on the average 1.5 to 3 % Potassium. (20) Guana is a very complex substance which is derived almost entirely from the excrements of sea birds and the birds themselves and from other animals.

The saline constituents of the juice of flesh are chiefly phosphates of Potassium, Magnesium, and a little chloride of sodium. (21) Potassium is the predominant alkali metal in the juice of flesh and sodium predominates in the blood, especially in the serum. The blood contains .323 p.p.t. of potassium.

The quantity of mineral bodies in the serum of man is about the same as in other animals. (22)

	Man.	Other Animals.
K_2O	.387-.401	.226-.27
Na_2O	4.29	4.25-4.42

After burning muscle the mineral ash amounts to about 10 to 15 p.p.m. The largest constituents are potassium and phosphoric acid. The next largest in amount are sodium and magnesium.

Potassium is found in the yolk of hens eggs, the ova of man and mammals, but for evident reasons these cannot be subject to a searching chemical amalysis.

The potassium combinations, especially the potassium phosphate, are of the greatest importance for the life and development of the cell, even though we do not know the nature of the importance.

The quantity of sodium and potassium eliminated from the urine by a healthy full grown body on a mixed diet, is according to Salkowski, 3-4 grams Potassium oxide and 5-8 grams Sodium oxide.

The average composition of human urine is 1.93 p.p.t. of potassium and .05 p.p.t. of sodium, chloride of sodium 7.22 p.p.t.

The fleeces of sheep contain a considerable proportion of a salt of potassium, with an animal acid; when the fleece is washed with water this salt is dissolved. (23)

The following results may be taken as typical of the average composition of the ashes of various classes of fuels: (24)

	Wood	Lignite	Coal
Potassium	4.13	.43	.22
Sodium	.32	trace	.10
Sodium Chloride	.85	"	trace

In the manufacture of cement by the Cottrell process a by-product containing 30 per cent potassium sulphate is found.

The problem of working out the ratio of Na to K in insects was suggested by the fact that Mr. E. E. Lyder found that the $K.NO_3$, which had been formed as a result of the weathering of bat guana, was practically free from $NaNO_3$, and it was assumed that this could be accounted for in that those insects on which the bats fed were richer in K than are ordinary animals.

GENERAL METHOD USED FOR THE ANALYSIS OF INSECTS.

Insects are weighed and ignited in a platinum crucible. The crucible is reweighed and the pereent of ash calculated. The ash is dissolved in concentrated hydrochloric acid and the percent of the ash that is insoluble in the acid is calculated, after filtering and weighing.

The filtrate is neutralized with ammonium hydroxide and solid powdered ammonium oxalate is added keeping the volume as small as possible. The precipitate is caught on a filter paper and the filtrate is evaporated to dryness and then heated to dull redness until all the ammonium salts are driven off.

The residue is taken up in a small amount of water, filtered, and washed; solid barium hydroxide is added and after no further precipitation solid ammonium carbonate is added to precipitate any excess of barium. The precipitate is caught on a filter paper and the filtrate evaporated to dryness, taken up with a little water, and again evaporated to dryness and ignited in a platinum dish at dull red heat. Weigh as potassium and sodium chloride.

Dissolve the mixed salt in a small amount of water. Calculate the amount of chlorplatinate solution needed, assuming the salt to be pure sodium chloride. Treat with a few more tenths of a c.c. than calculated, evaporate the liquid almost to dryness on a water bath, being careful to keep the temperature below 100 degrees C. Cool and add a few c.c. of absolute alcohol. Break up the mass and decant the liquid through a filter moistened with alcohol.

The treatment of the residue with alcohol and the breaking up to a powder is repeated until the alcohol runs through practically colorless and the salt assumes a pure golden yellow color without any of the orange sodium chlorplatinate being present. (25)

Alcohol of 80 % strength should be used for washing, as sodium chlorplatinate is more soluble in 80 % alcohol than it is in absolute alcohol. The precipitate is then transferred to a crucible and ignited and weighed as potassium chlorplatinate. To find the amount of potassium chloride present multiply by .3056. This number is used instead of .3070 because potassium chlorplatinate is not the formula as it contains a slight excess of chlorine. When successive determinations are to be made Gooche's apparatus is used for washing and weighing the potassium chlorplatinate. (26)

KCl	times	.5246	equals	K.
K_2PtCl_6	times	.3056	equals	KCl.
NaCl	times	.5306	equals	Na.

THE DETERMINATION OF THE Na AND K IN INSECTS.

LIVE LARVAE OF THE POTATO BUG.

	1.	2.
Weight of platinum crux. plus bugs	35.99160	35.2224
Weight of platinum crux.	17.14516	17.1326
Weight of live larvae	18.84644	18.0898
Weight after heating (Crux. and ash)	17.4074	17.3887
Weight of crux.	17.14516	17.1326
Weight of ash	.26224	.2561
Percent of ash	1.397 %	1.417 %
Average percent of ash	1.41 %	
Weight of Crux. plus mixed salt	17.2774	17.2612
Weight of Crux.	17.1445	17.1323
Weight of the mixed salt	.1329	.1289
Weight of the ash insoluble in HCl plus the weight of the crux.	6.2611	5.9427
Weight of the crux.	6.2385	5.9211
Weight of ash insol. in HCl	.0226	.0216
Percent of ash insol.	8.61 %	8.44 %
Average percent of ash insol. in HCl	8.52 %	

Potato Bug.

Weight of K_2PtCl_6 plus Gooch crux.	15.5572
Weight of Gooch crux.	15.2860
Weight of K_2PtCl_6	.2712
Multiply by .3056 gives KCl from the ash	.0828787
Multiply by .5246 gives K from the ash	.0434780
Percent of K in the ash	16.97 %
Percent of K in the live larvae	.24 %
Percent of K in that part of the ash that is soluble in HCl	18.54 %
Percent of Na in the ash	9.53 %
Percent of Na in the live larvae	.14 %
Percent of Na in that part of the ash that is soluble in HCl	10.42 %
In the ash	Na:K::1:1.780
In that part of the ash that is sol. on adding HCl	Na:K::1:1.779
In the live larvae	Na:K::1:1.71

MOTH.
Several kinds and various sizes.

Weight of moths taken	4.4760
Weight of ash plus platinum crux.	17.2281
Weight of crux.	17.1445
Weight of ash	.0836
Percent of ash	1.87 %
Weight of matter insol. in HCl plus crux.	5.4572
Weight of crux.	5.4388
Weight of ash insol. in HCl	.0189
Percent of ash insol. in HCl	22.6 %
Weight of crux. plus the mixed salt	17.1723
Weight of crux.	17.1440
Weight of the mixed salt	.0283
Weight of Gooch plus K_2PtCl_6	14.9114
Weight of Gooch	14.8569
Weight of K_2PtCl_6	.0545
Calculated weight of KCl	.016655
Calculated weight of NaCl	.011645

MOTH.

Calculated weight of Potassium as chloride	.016655
Calculated weight of Sodium as chloride	.011645
Calculated weight of Potassium	.008747
Calculated weight of Sodium	.006175

Percent of K in the ash	10.46 %
Percent of K in that part of the ash sol. in HCl	13.51 %
Percent of K in total bug	.20 %

Percent of Na in the ash	77.38 %
Percent of Na in that part of the ash sol. in HCl	9.54 %
Percent of Na in the total moth	.14 %

In the ash	Na:K::1:1.418
In that part of the ash sol in HCl	Na:K::1:1.416
In the total moth	Na:K::1:1.42

JUNE BUGS.

Weight of bugs taken	9.8652
Weight of crux. plus ash	17.3852
Weight of crux.	17.1323
Weight of ash	.2529
Percent of ash	2.56 %
Weight of crux plus matter insol. in HCl	6.3312
Weight of crux.	6.2397
Weight of matter insol. in acid	.0915
Percent of ash insol. in HCl	36.18 %
Weight of crux. plus Na and KCl	17.2239
Weight of crux.	17.1440
Weight of the mixed salt	.0799
Weight of Gooch plus K_2PtCl_6	16.1307
Weight of crux.	15.9674
Weight of K_2PtCl_6	.1633
Calculated weight of KCl	.049904
Calculated weight of NaCl	.029996

JUNE BUGS.

Calculated weight of K	.0261596
Calculated weight of Na	.015906
Percent of K in the ash	10.34 %
Percent of K in that part of the ash sol. in HCl	16.20 %
Percent of K in the total June Bug	.27 %
Percent of Na in the ash	6.29 %
Percent of Na in that part of the ash that is sol.in HCl	9.85 %
Percent of Na in the total June Bug	.16 %
In the ash	Na:K::1:1.643
In that part of the ash sol. in HCl	Na:K::1:1.644
In the total June Bug	Na:K::1:1.68

STAG BEETLE.

Weight of Stag Beetle taken	6.5800
Weight of crux. plus ash	17.2592
Weight of crux.	17.1443
Weight of ash	.1149
Percent of ash in the stag beetle	1.75 %
Weight of crux plus insol. ash	5.9512
Weight of crux.	5.9228
Weight of ash insol. in HCl	.0284
Percent of ash insol. in HCl	24.71 %
Weight of crux. plus Na and KCl	17.1744
Weight of crux.	17.1316
Weight of mixed salt	.0428
Weight of Gooch plus the mixed salt	16.3100
Weight of Gooch	16.2326
Weight of K_2PtCl_6	.0774
Calculated weight of KCl	.02365
Calculated weight of NaCl	.01915

STAG BEETLE.

Weight of K in ash of Stag Beetle	.0124067
Weight of Na in the ash of Stag Beetle	.010155
Percent of K in the ash	10.79 %
Percent of K in that part of the ash sol.in HCl	14.34 %
Percent of K in the total stag beetle	.19 %
Percent of Na in the ash	8.83 %
Percent of Na in that part of the ash sol. in HCl	11.73 %
Percent of Na in the total stag beetle	.15 %
In the ash	Na:K::1:1.222
In that part of the ash sol. in HCl	Na:K::1:1.222
In the total stag beetle	Na:K::1:1.26

GRASSHOPPERS.

Various kinds and various sizes.

Weight of Grasshoppers taken	13.8850
Weight of crux. plus ash	17.3790
Weight of crux.	17.1316
Weight of ash	.2474
Percent of ash in grasshoppers	1.78 %
Weight of ash insol. in HCl plus crux.	5.6401
Weight of crux.	5.6105
Weight of ash insol. in HCl	.0296
Percent of ash insol. in HCl	11.96 %
Weight of crux. plus mixed salt	17.1931
Weight of crux.	17.1316
Weight of the mixed salt	.0615
Weight of Gooch plus Potassium chlorplatinate	15.4339
Weight of Gooch	15.2792
Weight of K_2PtCl_6	.1547
Calculated weight of KCl	.04727632
Calculated weight of NaCl	.014224

GRASSHOPPERS.

Weight of K in the ash	.024801
Weight of Na in the ash	.0075429
Percent of K in the ash	10.02 %
Percent of K in that part of the ash sol. in HCl	11.38 %
Percent of K in the total grass hopper	.18 %
Percent of Na in the ash	3.05 %
Percent of Na in that part of the ash sol. in HCl	3.46 %
Percent of Na in total grasshopper	.05 %
In the ash	Na:K::1:3.285
In that part of the ash sol. in HCl	Na:K::1:3.288
In the total grasshopper	Na:K::1:3.60

BRAN BUG. TENEBRO MOLITOR.
Adult of corn meal worm.

Weight of bug taken	22.5260
Weight of crux. plus ash	17.4702
Weight of crux.	17.1440
Weight of ash	.3262
Percent of ash	1.44 %
Weight of crux plus ash insol. in HCl	17.1558
Weight of crux.	17.1440
Weight of ash insol. in HCl	.0118
Percent of ash insol. in HCl	3.61 %
Weight of crux. plus Na and K as sulphate	17.2813
Weight of crux.	17.1316
Weight of Na and K as sulphate	.1497
Weight of crux plus K_2PtCl_6	15.5960
Weight of crux.	15.2735
Weight of K_2PtCl_6	.3225
Calculated weight of KCl	.098556
Calculated weight of K_2SO_4	.11518
Calculated weight of Na_2SO_4	.03452

TENEBRO MOLITOR.

Weight of K in the ash	.0517024
Weight of Na in the ash	.011177
Percent of K in the ash	15.85 %
Percent of K in that part of the ash sol. in HCl	16.44 %
Percent of K in the total	.23 %
Percent of Na in the ash	3.42 %
Percent of Na in that part of the ash sol. in HCl	3.55 %
Percent of Na in the total	.05 %
In the ash	Na:K::1:4.634
In that part of the ash sol. in HCl	Na:K::1:4.631
In the total	Na:K::1:4.60

COCKROACHES.

Weight of cockroaches taken	1.8430
Weight of cockroaches taken	10.1250
Total weight of cockroaches taken	11.9680
Weight of crux. plus the ash of cockroaches	17.3857
Weight of the crux.	17.1440
Weight of the ash from the cockroaches	.2417
Percent of the ash	2.01 %
Weight of crux. plus ash insol. in HCl	17.2340
Weight of crux.	17.1316
Weight of ash insol. in HCl	.0424
Percent of ash insol. in HCl	17.54 %
Weight of crux. plus mixed salt	17.2342
Weight of crux.	17.1316
Weight of the mixed salt plus inpurities	.1026
Weight of crux. plus inpurities from mixed salt	6.2428
Weight of crux.	6.2371
Weight of impurities	.0057
Calculated weight of pure mixed salt	.0969

COCKROACHES.

Weight of crux. plus K_2PtCl_6	16.4552
Weight of crux.	16.2486
Weight of K_2PtCl_6	.2066
Estimated weight of KCl	.063136
Estimated weight of NaCl	.03376
Estimated weight of K	.033111
Estimated weight of Na	.0179
Percent of K in the ash	13.70 %
Percent of K in that part of the ash sol. in HCl	16.61 %
Percent of K in the total cockroaches	.18 %
Percent of Na in the ash	7.41 %
Percent of Na in that part of the ash sol. in HCl	8.99 %
Percent of Na in the total	.15 %
In the ash, the	Na:K::1:1.848
In that part of the ash sol. in HCl	Na:K::1;1.847
In the total cockroaches	Na:K::1:1.20

BEES.

Several kinds used, both large and small.

Weight of Bees taken	2.6015
W	
Weight of crux. plus ash	17.1607
Weight of crux.	17.1316
Weight of ash	.0291
Percent of ash	1.12 %
Weight of crux. plus ash insol. in HCl	17.1342
Weight of crux.	17.1316
Weight of ash insol. in HCl	.0026
Percent of ash insol. in HCl	8.95 %
Weight of crux. plus mixed salt	17.1571
Weight of crux.	17.1440
Weight of the mixed salt plus impurities	.0131.
Weight of crux. plus impurities	5.6112
Weight of crux.	5.6105
Weight of impurities	.0007
Calculated weight of the mixed salt	.0124

BEES.

Weight of Gooch crux. plus K_2PtCl_6	16.0052
Weight of Gooch	15.9805
Weight of K_2PtCl_6	.0247
Calculated weight of KCl	.007538
Calculated weight of NaCl	.00486
Weight of K in the ash	.003959
Weight of Na in the ash	.002577
Percent of K in the ash	13.59 %
Percent of K in that part of the ash sol. in HCl	14.93 %
Percent of K in the total	.15 %
Percent of Na in the ash	8.86 %
Percent of Na in that part of the ash sol. in HCl	9.72 %
Percent of Na in the total	.10 %
In the ash	Na:K::1:1.533
In that part of the ash sol. in HCl	Na:K::1:1.536
In the total	Na:K::1:1.50

SMALL CARABIDAE BEETLE.

	1.	2.
Weight taken	3.0656	3.0656
Weight of crux. plus ash	17.2583	17.2445
Weight of crux.	17.1440	17.1315
Weight of ash	.1143	.1130
Percent of ash	3.72 %	3.68 %
Weight of crux. plus mixed salt	17.1623	17.1495
Weight of crux.	17.1440	17.1315
Weight of the mixed salt and impurities	.0183	.0180
Weight of crux plus impurities	5.6134	6.2461
Weight of crux.	5.6112	6.2428
Weight of impurities	.0022	.0033
Weight of pure mixed salt	.0160	.0147
Weight of Gooch plus K_2PtCl_6	14.9230	15.3427
Weight of Gooch	14.8824	15.3092
Weight of K_2PtCl_6	.0406	.0335
Percent of K in the ash	4.81 %	4.74 %
Percent of K in total	.18 %	.18 %
Percent of Na in the ash	1.71 %	2.09 %
Percent of Na in the total	.06 %	.08 %

SMALL CARABIDAE BEETLE.

		1	2
In the ash	Na:K::	1:2.801	2.268
In the total	Na:K::	1:3.00	2.25

LIGHTNING BUGS.

Weight of Bugs taken	2.6700
Weight of crux plus ash	17.1850
Weight of crux.	17.1440
Weight of ash	.0410
Percent of ash	1.54 %
Weight of ash insol. in HCl plus crux.	17.1483
Weight of crux.	17.1440
Weight of ash insol. in HCl	.0043
Percent of ash insol. in HCl	10.49 %
Weight of crux. plus mixed salt	17.1829
Weight of crux.	17.1440
Weight of the mixed salt	.0389
Weight of impurities	.0038
Weight of the mixed salt(possibly impure) (as to sodium)	.0351
Weight of crux plus K_2PtCl_6	16.4950
Weight of crux.	16.4552
Weight of K_2PtCl_6	.0398
Calculated weight of KCl	.012162
Weight of K in the ash	.0063807
Percent of K in the ash	15.56 %
Percent of K in the total	.23 %

FLIES.

First batch were new dead flies.

Second batch were dead for a year.

	1.	2.
Weight of flies taken	1.1900	
Weight of crux. plus ash	17.1548	18.0499
Weight of crux.	17.1316	17.1440
Weight of ash	.0232	.9059
Percent of ash	1.95 %	
Weight of crux. plus ash insol. in HCl	17.1334	
Weight of crux.	17.1316	
Weight of ash insol. in HCl	.0018	
Percent of ash insol. in HCl	7.76 %	
	(2)	
Weight of Na and K as sulphates (plus crux.)	17.3261	
Weight of crux.	17.1440	
Weight of Na and K as sulphates	.2821	
Weight of crux. plus K_2PtCl_6	15.3217	
Weight of crux.	14.8823	
Weight of K_2PtCl_6	.4394	
Calculated weight of KCl	.13428	

FLIES.

Calculated weight of K_2SO_4	.1569
Calculated weight of Na_2SO_4	.1252
Calculated weight of K in the ash	.070463
Calculated weight of Na in the ash	.05646
Percent of K in the ash	7.78 %
Percent of K in that part of the ash sol. in HCl	8.20 %
Percent of K in the total	.15 %
Percent of Na in the ash	6.23 %
Percent of Na in that part of the ash sol. in HCl	6.75 %
Percent of Na in total	.12 %
In the ash	Na:K::1:1.24
In that part of the ash sol. in HCl	Na:K::1:1.21
In the total	Na:K::1:1.25

S U M M A R Y.

	Percent K in ash	Percent K in total.	Percent Na in ash.
Larvae of Potato Bug	16.97	.24	9.53
Adult Moth	10.46	.20	7.38
Adult June Bug	10.34	.27	6.29
Adult Stag Beetle	10.79	.19	8.83
Adult Grasshopper	10.20	.18	3.05
Adult Tenebro Molitor	15.85	.23	3.42
Adult Cockroach	13.70	.18	7.41
Adult Bee	13.59	.15	8.86
Adult Carabidae Beetle	4.81	.18	1.71
Adult Carabidae Beetle	4.74	.18	2.09
Adult Lightning Bug	15.56	.23	
Flies	7.78	.15	6.23

	Percent of Na in total	Na:K::1: in ash	Na:K::1 in total
Larvae of Potato Bug	.14	1.780	1.780
Adult Moth	.14	1.418	1.418
Adult June Bug	.16	1.643	1.643
Adult Stag Beetle	.15	1.222	1.222
Adult Grasshopper	.05	3.285	3.285
Adult Tenebro Molitor	.05	4.634	4.634
Adult Cockroach	.15	1.848	1.848
Adult Bee	.10	1.533	1.533
Adult Carabidae Beetle	.06	2.801	2.801
Adult Carabidae Beetle	.08	2.268	2.268
Adult Fly	.12	1.24	1.24

S U M M A R Y.

The Potassium in insects varies from .18 per cent to .27 per cent. The Sodium in insects varies from .05 per cent to.16 per cent.

C O M P A R I S O N S.

Ratio of Na:K

Ratio of Na:K:1:X

Ratio in Insects 1.20 - 4.60

Ratio in Humans 1.33

C O M P A R I S O N S.

	Percents of K_2O and Na_2O	
	K_2O	Na_2O
Chlorophyl of Sugar Beets	.43	
Barley	.57	
Rice	.1	.003
Bullock's blood	.2	1.9
Oats, wheat, rye	.5-.6	.01½-.04
Dogs Milk	.5-.6	.02 -.03
Apples	1.1	.1
Peas	1.2	.2
Milk of herbivora	.9-1.7	.1-1.
Beef	1.9	.3
Beans	2.1	.01
Strawberries	2.2	.02
Potatoes	2.-2.8	.03-.06
Fish meal and manure	2.-4.	
Bat guano	1.5-3.	

SUMMARY.

Some bats feed on insects, some on fruit and some on blood. Some of the insects which they destroy are moths, cutworms, beetles, flies, bedbugs, mosquitoes, etc. Some species are said to live largely on mosquitoes.

It is a recognized principle among physiologists that where a muscle must work rapidly, its K content is relatively high. It will be noted from the table that in practically all of the more active insects the K content is high. The more sluggish insects are lower in K. While an analysis was not made for mosquitoes, it could be assumed that they are high in K, because they are very active. From this, it could be concluded that the small amount of $NaNO_3$ found in the weathered bat guano was due to the excess of K found in the bodies of the insects upon which the bats fed.

COMPARISONS.

	Ratio of Na to K (Na:K::1:X)
Active Insects	
Adult Grasshopper	3.60
Adult Tenebro Molitor	4.60
Adult Carabidae Beetle	3.00
Adult Bee	1.50
Adult Fly	1.25
Sluggish Insects	
Larvae of Potato Bug	1.71
Adult June Bug	1.42
Adult Stag Beetle	1.26
Adult Cockroach	1.20

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